Final report MO-2015-201: Passenger ferry *Kea*, collision with Victoria Wharf, Devonport, 17 February 2015

The Transport Accident Investigation Commission is an independent Crown entity established to determine the circumstances and causes of accidents and incidents with a view to avoiding similar occurrences in the future. Accordingly it is inappropriate that reports should be used to assign fault or blame or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose.

The Commission may make recommendations to improve transport safety. The cost of implementing any recommendation must always be balanced against its benefits. Such analysis is a matter for the regulator and the industry.

Final Report

Marine inquiry MO-2015-201
Passenger ferry *Kea*,
collision with Victoria Wharf, Devonport,
17 February 2015

Approved for publication: August 2017

Transport Accident Investigation Commission

About the Transport Accident Investigation Commission

The Transport Accident Investigation Commission (the Commission) is a standing commission of inquiry and an independent Crown entity responsible for inquiring into maritime, aviation and rail accidents and incidents for New Zealand, and co-ordinating and co-operating with other accident investigation organisations overseas. The principal purpose of its inquiries is to determine the circumstances and causes of occurrences with a view to avoiding similar occurrences in the future. Its purpose is not to ascribe blame to any person or agency or to pursue (or to assist an agency to pursue) criminal, civil or regulatory action against a person or agency. The Commission carries out its purpose by informing members of the transport sector and the public, both domestically and internationally, of the lessons that can be learnt from transport accidents and incidents.

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Important notes

Nature of the final report

This final report has not been prepared for the purpose of supporting any criminal, civil or regulatory action against any person or agency. The Transport Accident Investigation Commission Act 1990 makes this final report inadmissible as evidence in any proceedings with the exception of a Coroner's inquest.

Ownership of report

Citations and referencing

Information derived from interviews during the Commission's inquiry into the occurrence is not cited in this final report. Documents that would normally be accessible to industry participants only and not discoverable under the Official Information Act 1982 have been referenced as footnotes only. Other documents referred to during the Commission's inquiry that are publically available are cited.

Photographs, diagrams and pictures

Unless otherwise specified, photographs, diagrams and pictures included in this final report are provided by, and owned by, the Commission.

Verbal probability expressions

The expressions listed in the following table are used in this report to describe the degree of probability (or likelihood) that an event happened or a condition existed in support of a hypothesis.

Terminology (adopted from the Intergovernmental Panel on Climate Change)	Likelihood of the occurrence/outcome	Equivalent terms
Virtually certain	> 99% probability of occurrence	Almost certain
Very likely	> 90% probability	Highly likely, very probable
Likely	> 66% probability	Probable
About as likely as not	33% to 66% probability	More or less likely
Unlikely	< 33% probability	Improbable
Very unlikely	< 10% probability	Highly unlikely
Exceptionally unlikely	< 1% probability	

Passenger ferry *Kea* at Auckland, March 2015

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Glossary

active control station	the control station selected by the master of a vessel to operate the steering and propulsion unit of the vessel
azimuth thruster	a type of marine propeller enclosed in a shroud that can be rotated to any horizontal angle, making a rudder unnecessary
bow	the forward part of the hull of a ship
bumpless mode	a method by which the steering and propulsion controls of a vessel are manually transferred from one control station to another. In this mode the levers on the inactive control stations do not automatically follow the movements of the control levers on the active control station
control console	a console used to control each azimuth thruster
control station	a station on the bridge of a vessel capable of controlling its steering and propulsion
follow-up mode	a method of steering a vessel where all control levers on all stations automatically mirror the movements of the control levers on the active control station
graphic display panel	an 8.4 inch, or 21.3 centimetre (cm), display panel fitted to each control console on each control station of a vessel. A number of operational parameters and alarms are displayed on the panel
inactive control stations	three of the four control stations on a vessel's bridge. The fourth is the active control station used to steer the vessel
non-follow-up mode	a mode available on each console on a vessel's control station to operate its steering and propulsion system as a back-up should the main follow-up mode and bumpless mode of steering and propulsion control system fail
stern	the back or aft-most part of a ship
wheelhouse	the enclosed part of a ship from where it is steered

Data summary

Vehicle particulars

Name:	*Kea*
Type:	passenger ferry – catamaran
Class:	Maritime Operator Safety System
Limits:	enclosed waters
Classification:	Maritime New Zealand
Length:	27.6 metres
Breadth:	10 metres
Gross tonnage:	105 tonnes
Built:	1988
Propulsion:	twin six-cylinder 272KW Cummins motors
Service speed:	12 knots
Owner/operator:	Fullers Group Limited
Port of registry:	Auckland
Minimum crew:	One

Date and time	17 February 2015, 1235
Location	Devonport
Persons involved	64
Injuries	seven persons treated at North Shore Hospital
Damage	significant impact damage to the *Kea*'s starboard bow

1. Executive summary

1.1. The *Kea* was a double-ended catamaran passenger ferry operating a 15 minute service between downtown Auckland and Devonport on Auckland's North Shore. The vessel was fitted with a propulsion unit on the forward end of the starboard hull and the aft end of the port hull and could be operated from the centre and starboard side of the wheelhouse. The entire control system for the propulsion units had been replaced with a similar control system less than four months before the accident.

1.2. At about 1030 on 17 February 2015, the *Kea* departed from the Auckland ferry terminal with 61 passengers on board. The master was the sole person on the bridge. As the *Kea* approached Devonport ferry terminal at its full service speed of 12 knots (about 22 kilometres per hour), the master transferred control of the two propulsion units from the vessel's centre console to the starboard wing console in preparation for berthing.

1.3. However, the control for only the port propulsion units transferred to the starboard wing console, which went unnoticed by the master.

1.4. The master attempted to slow the ferry by manipulating the control lever for the starboard propulsion unit, and soon realised that the unit was not responding. The master made several unsuccessful attempts to gain control of the starboard propulsion unit.

1.5. Realising that the *Kea* was fast approaching the ferry terminal, the master aborted the berthing and used the port propulsion unit in an attempt to turn the ferry away from the surrounding wharves and head back into the harbour. He soon realised that he would not be able to avoid a collision with an adjacent wharf, so used the port propulsion unit to slow the ferry. The *Kea* struck the wharf at a speed of eight knots (about 16 kilometres per hour). The starboard propulsion unit remained at full speed ahead throughout the sequence.

1.6. The *Kea* sustained significant damage to its starboard hull above the waterline and many passengers received minor injuries. Seven passengers were hospitalised with non-life-threatening injuries.

1.7. The Commission **found** that it was about as likely as not that the master lost control of the starboard propulsion system because he did not fully press the 'give-away' button on the centre console before taking control at the wing console.

1.8. The Commission also **found** that the master had not been sufficiently trained in and familiarised with the *Kea*'s new control system, and did not know how to use two other features that he could have used to prevent the collision.

1.9. The Commission also **found** that Fullers did not adequately manage the risks associated with the replacement of the *Kea*'s propulsion control system and the vessel's re-entry to service, and that the replacement project should have been afforded a greater level of regulatory scrutiny by a surveyor.

1.10. The Commission identified four **safety issues**:

- the Fullers training and familiarisation system failed to ensure that the master was properly trained in and familiar with the *Kea*'s propulsion control system
- the Fullers system allowed the *Kea* to enter and continue service using the follow-up mode of operation, despite the company knowing that there were faults with that mode that were resulting in incidents
- the regulatory system did not ensure an appropriate level of surveyor oversight of the project to replace the *Kea*'s propulsion control system
- Fullers had not assessed the risk of operating ferries with unsecured passenger seating.

1.11. Fullers took safety actions to address three of the safety issues. The Commission made one recommendation to Maritime New Zealand to address the fourth.

1.12. The key lessons arising from this inquiry were:

- masters and other bridge crew must use all available means for monitoring the status of their manoeuvring and control systems, all the time, to maintain good situational awareness
- masters must be properly trained in and fully familiar with all aspects of their vessels' control systems and equipment before being allowed to take command of them
- the regulatory requirements contained in Acts, Maritime Rules and other statutory instruments are minimum requirements with which maritime operators must comply. They do not relieve operators of their responsibility to assess all risks in their operations, and reduce those risks to as low as reasonably practicable.

2. Conduct of the inquiry

2.1. On 17 February 2015, the Transport Accident Investigation Commission (Commission) learned through the media of an accident involving the passenger ferry *Kea* at Victoria Wharf, Devonport.

2.2. The Commission opened an inquiry under section 13(1)b of the Transport Accident Investigation Commission Act 1990 and appointed an investigator in charge.

2.3. Two investigators from the Commission travelled to Auckland on the same day to conduct interviews and gather evidence.

2.4. A questionnaire was distributed to passengers on board the ferry to gather further information on the accident.

2.5. On 3 March 2015, two investigators travelled to the Fullers office in Auckland to conduct further interviews and gather evidence.

2.6. On 28 June 2017, the Commission approved a draft report for circulation to interested persons.

2.7. The draft report was circulated to nine interested persons and one submission was received.

2.8. The Commission has considered in detail this submission and any changes as a result of this submission have been included in the final report.

2.9. The Commission approved the report for publication on 23 August 2017.

3. Factual information

3.1. Background

3.1.1. Built in 1988, the *Kea* was a commercial passenger ferry that conducted regular runs between Auckland's central business district (CBD) and Devonport on Auckland's North Shore.

3.1.2. In 2013, the owner of the vessel (Fullers Group Limited) decided to replace the *Kea*'s ageing propulsion and steering control system. Fullers awarded the contract to a Netherlands-based company (ZF Marine), which had manufactured the original control system fitted on the *Kea*.

3.1.3. The contract required the new control system to have a follow-up functionality, which was new in the scope of supply for ZF Marine. It had not supplied a marine control system with follow-up functionality before. Fullers was only made aware of this at the time of commissioning the new system.

3.1.4. The replacement of the control system was discussed with a marine surveyor, and it was decided that within the meaning of Maritime Rules Part 44 the work was not a major modification and therefore did not require the surveyor's supervision.

3.1.5. Work on the new propulsion and steering control system was undertaken at Oceania Marine Limited's shipyard in Whāngārei between 15 August 2014 and 22 October 2014. The *Kea* returned to service on 29 October 2014.

3.2. The new propulsion and steering arrangement

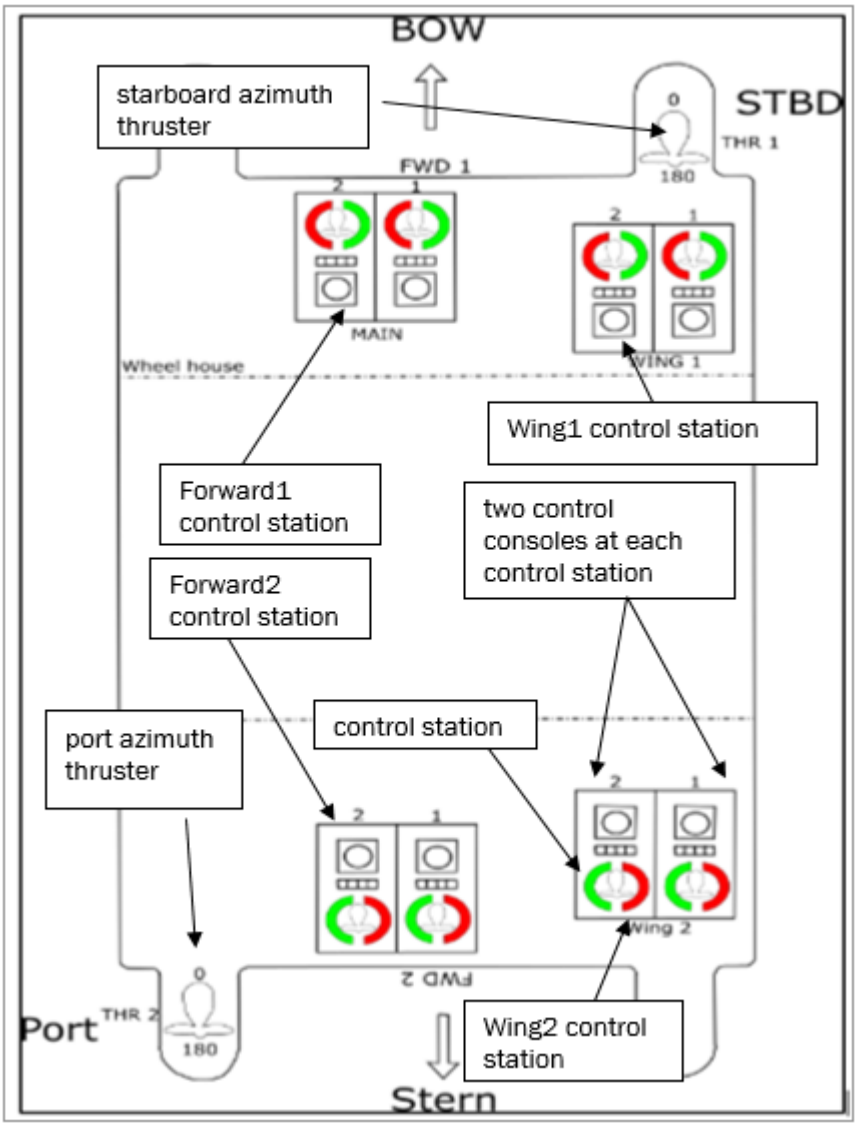


Figure 1
Schematic diagram of the *Kea*'s propulsion and steering control system

3.2.1. The *Kea* was a twin-hulled vessel with an identical bow[1] and stern.[2] Propulsion and steering were provided by two azimuth thrusters,[3] one fitted on the forward end of the starboard hull and the other on the aft end of the port hull. The azimuth thrusters comprised a fixed-pitch propeller enclosed in a shroud that could be rotated 360°.

3.2.2. Two sets of identical steering control stations were used to drive the vessel in either direction, without the need to turn around off the berth. Each control station had two control consoles[4] (see Figure 1). Each console was fitted with a control lever and graphic display panel[5] to operate the azimuth thruster units (see Figure 4). Two control stations were located on the

[1] The bow is the forward part of the hull of a ship.
[2] The stern is the back or aft-most part of a ship.
[3] An azimuth thruster is a type of marine propeller enclosed in a shroud that can be rotated to any horizontal angle, making a rudder unnecessary.
[4] The control console is used to control each azimuth thruster.
[5] The graphic display panel was an 8.4 inch (21.3 cm) display panel. A number of operational parameters and alarms were displayed on the panel.

forward side of the wheelhouse:[6] Forward1 station and Wing1 station (see Figure 1). Two stations on the aft side, Forward2 station and Wing2 station, were located symmetrically opposite and identical to the forward stations (see Figure 2). The *Kea* was normally controlled from the wing stations when manoeuvring off the wharf. Once clear of the wharf the normal option was to transfer control to the forward control station on the centreline for better visibility and access to navigational equipment.

Figure 2
The *Kea*'s wheelhouse layout

3.2.3. Each control station was fitted with two control levers, one for each azimuth thruster. The levers both controlled the propeller revolution speed and rotated to control the thruster steering angle. Each console had a graphic display panel showing various propulsion and steering parameters (see Figure 4).

[6] The wheelhouse is the enclosed part of a ship from where it is steered.

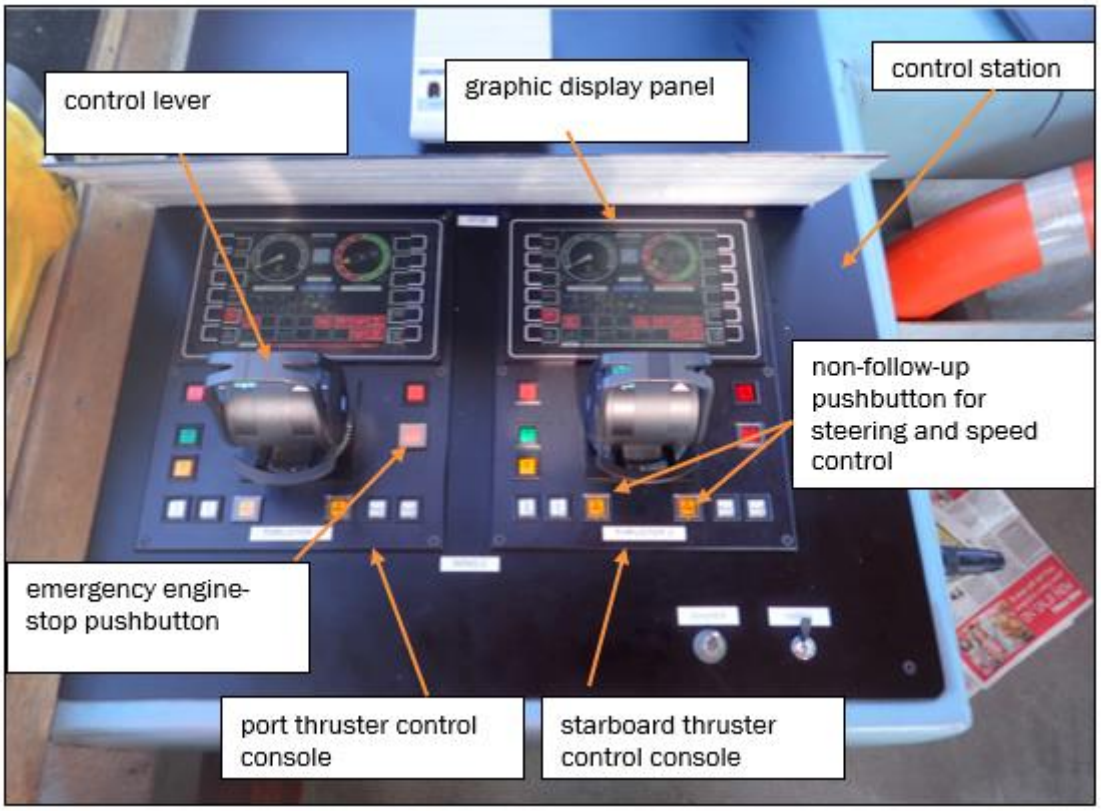


Figure 3
Control station layout

3.3. Modes of operation

3.3.1. The control levers were designed to be operated in follow- up[7] mode, bumpless mode[8] or the emergency non-follow-up[9] mode. To transfer control between control stations in either follow-up mode or bumpless mode the two levers on the receiving control station had to be aligned with those of the active control station[10] (from where the vessel was being controlled). In case of an emergency, the vessel could be operated using the emergency non-follow-up mode.

3.3.2. In follow-up mode, automation ensured that all control levers on the bridge followed and were always aligned. A transfer of control was initiated by pressing the 'give-away' control push buttons on the active control station (see Figure 5). Control could be transferred to any of the other three control stations on the bridge. Pressing the give-away button triggered an audible alarm and a visual indication on the graphic display panels at all control stations. To take control at the receiving control station, the 'accept control' push buttons (see Figure 4) had to be pressed, which also stopped the audible and visual alarms. This indicated that the transfer was complete. The audible alarm sounded three times in a period of about 10 seconds and then stopped for about 20 seconds before sounding again. This sequence continued until the control transfer was cancelled or accepted.

[7] The follow-up mode is a method of steering where all control levers on all stations automatically mirror the movements of the control levers on the active control station.
[8] The 'bumpless mode' is a method of steering where the levers on the inactive control stations do not automatically follow the movements of the control levers on the active control station.
[9] A mode is available on each console on a vessel's control station to operate its steering and propulsion system as a back-up should the main 'follow-up' mode and bumpless mode of steering and propulsion control system fail.
[10] The active control station is the station selected by the master of a vessel to operate the steering and propulsion unit of the vessel.

3.3.3. Control could also be transferred by manually aligning the levers on both stations prior to initiating the same transfer sequence. This method was described in the control system manual as 'bumpless control transfer'.

3.3.4. At the time of the accident the master was using the control system in the bumpless mode while technical issues with the follow-up system were being resolved by the manufacturer.

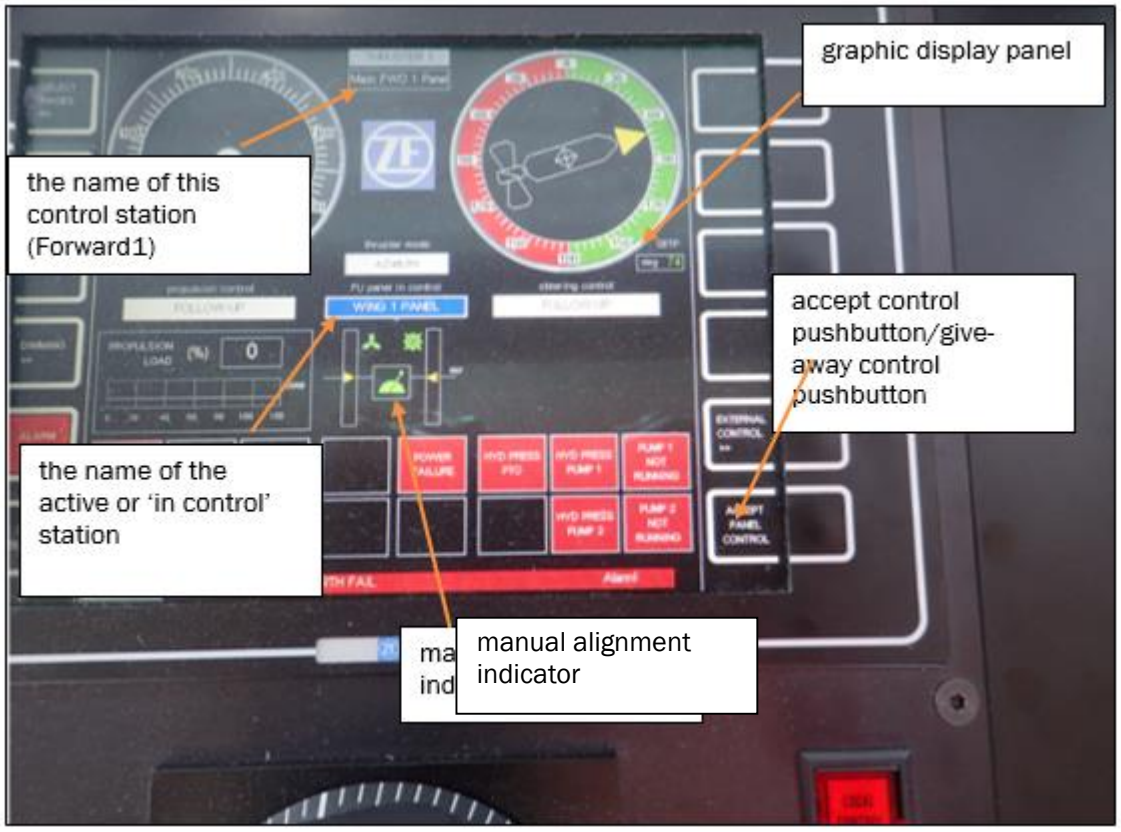


Figure 4
Graphic display panel

3.4. The refit

3.4.1. On 15 August 2014, the *Kea* had travelled to Whāngārei for maintenance work at the Oceania Marine shipyard. A number of repairs were to be undertaken during the installation of the new control system.

3.4.2. The components included eight Version1 control levers, which were shipped from the Netherlands to New Zealand. Prior to delivery, a 'factory acceptance test' of the new Version1 control levers was performed in the Netherlands by ZF Marine. The test found inconsistencies in the follow-up function and that the levers were not meeting the company's quality standards. It was decided to supply the control system with Version1 levers and aim to replace them with improved Version2 levers at the time of commissioning.

3.4.3. Fullers undertook the installation work and contracted it to Oceania Marine. The project was overseen by Fullers' electrical team leader on behalf of the asset manager, who was busy with other projects. The electrical team leader was a registered electrician who had been working for Fullers since 2000.

3.4.4. On 13 October 2014, a ZF Marine engineer travelled to New Zealand to commission the new control system. Only four Version2 control levers were available, but ZF Marine intended to provide the remaining four levers before the end of commissioning. The company soon realised that it would not be able to meet that deadline.

3.4.5. On 19 October 2014, a series of harbour trials was carried out with the new control system. The trials were noted in ZF Marine's service report as being carried out to the satisfaction of the master. The ZF Marine engineer and the electrical team leader were also on board during the trials. On completion of the trials the master felt confident to sail the vessel from Whāngārei to Auckland.

3.4.6. The master received training on the operation of the new controls. He said it was not a formalised instruction but an interactive session with lots of questions and answers.

3.4.7. On 20 October 2014, the commissioning work was completed. The ZF Marine service report noted that the follow-up modes on the Forward1 and Forward2 control stations were not working properly. Before countersigning the document, the electrical team leader contacted the asset manager, who instructed him to sign the document on his behalf if he was satisfied with the performance and functional reliability of the new control system. The document was signed and the vessel travelled back to Auckland on 22 October 2014.

3.5. The return to service

3.5.1. When the *Kea* returned to Auckland, the master instructed other *Kea* masters on the operation of the new control system.

3.5.2. The surveyor was invited to inspect the vessel and attend a sea trial. As part of the sea trial he asked the master to operate the vessel in follow-up and non-follow-up mode. The system performed without fault during this demonstration. The surveyor was then satisfied that the vessel was safe to return to service. The surveyor was not provided with a copy of the ZF Marine service report.

3.5.3. The *Kea* resumed commercial service on 29 October 2014, but suffered a series of control system failures related to the follow-up mode of operation.

3.5.4. For example, on 2 November 2014, the Wing2 control station's follow-up function stopped responding while the vessel was underway. The master used the emergency non-follow-up controls to berth the vessel.

3.5.5. Following this incident the vessel was removed from commercial service. On 8 November 2014, ZF Marine engineers replaced the four remaining Version1 control levers with Version2 control levers. Sea trials were conducted, but the control levers again failed in follow-up mode. Fullers decided to continue operating the vessel in follow-up mode while ZF Marine engineers developed a third version of the control lever.

3.5.6. The vessel resumed normal service on 12 November 2014. The vessel suffered a control system failure the same day. On 20 November 2014, the vessel suffered two further in-service failures related to the follow-up mode of the control system. The *Kea* was again removed from service.

3.5.7. Fullers conducted a risk assessment and decided that it would disable the faulty follow-up function on the control system while continuing to operate the vessel.

3.5.8. Fullers issued a memorandum to all *Kea* masters and duty managers on 21 November 2014 (see Appendix 1 for the full memorandum). The main instructions outlined in the memorandum were:

- All vessel control to be done from the wing position
- Follow-up function not to be reinstated under any circumstances unless agreed by the Asset Manager
- Additional watch keeping crew to be available to the master should they be requested
- Any 'givea-way' or 'accept control' to be done with plenty of sea room available unless tied alongside at Devonport or Downtown Ferry Basin
- Any future control issues to be recorded in vessel log

- Only experienced masters who have been instructed in the use of the controls in the manual position to be in command of the vessel.

3.5.9. A senior *Kea* master subsequently requested that masters be allowed to transfer control to the forward control station because of poor visibility from the wing station. On 25 November 2014, Fullers released a second memorandum, revising the first bullet point in the original memorandum to read:

- Central Controls may be used between Auckland and Devonport, however wing control position must be resumed about abeam of the naval dry dock on the Auckland-Devonport (route) and between Captain Cook and Queens Wharf on the Devonport-Auckland (route).

3.6. Narrative

3.6.1. At about 0430 on 17 February 2015, the master and two crew members boarded the *Kea* and started preparing the vessel for its regular service between Auckland's CBD and Devonport.

3.6.2. The master was designated a relief master, qualified to operate the *Kea* when a permanent master was unavailable.

3.6.3. The master followed the checklist and tested the propulsion and steering control system from the wheelhouse, and confirmed that it was working properly prior to departure. In accordance with the revised memorandum, he was using the *Kea*'s control system with the follow-up mode disabled. The change over between consoles was made using the bumpless mode.

3.6.4. The vessel departed at about 0545 from the Auckland ferry terminal on the first run of the day.

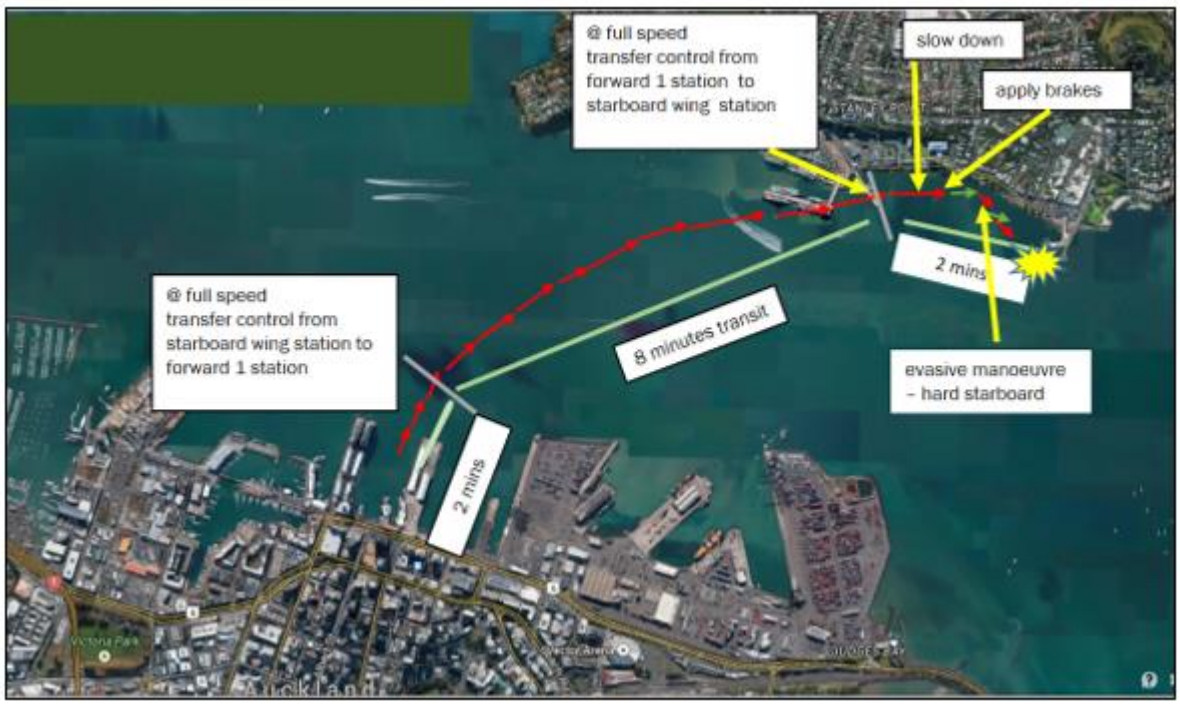


Figure 5
The *Kea*'s route from Auckland's CBD to Devonport

3.6.5. For the first couple of runs prior to sunrise, the relief master controlled the ferry from the wing stations. Shortly after sunrise the master decided to transfer control to the centre control stations after clearing the harbour basin, to avoid being blinded by sun-strike through the starboard wheelhouse window.

3.6.6. At about 1030, the *Kea* departed from the Auckland ferry terminal with 61 passengers on board and came up to full speed when it cleared the basin.

3.6.7. Once the vessel was up to speed and heading towards Devonport, the master transferred control from the Wing1 control station to the Forward1 control station.

3.6.8. In the vicinity of Devonport Naval Base the master initiated the transfer process from the Forward1 station back to the Wing1 control station in preparation for arrival at the Devonport ferry terminal. The *Kea* was still travelling at full speed at that time.

3.6.9. The master pressed the give-away button next to each control lever and heard the audible alarm sound as he walked over to press the accept-control buttons on the Wing1 control station. At about that time the audible alarm stopped sounding. The master believed that the transfer had been successful and that he now had control of both azimuth thrusters from the Wing1 station. He did not look at the status of each control lever to confirm that this was the case.

3.6.10. The vessel proceeded a further 100 metres towards Devonport before the master decided to reduce the revolutions on the engines. The master heard the sound of the port azimuth thruster engine reduce and assumed that both azimuth thrusters had slowed down.

3.6.11. He then rotated the lever controlling the starboard thruster to initiate a braking manoeuvre. He was expecting a reduction in vessel speed, but soon realised that the starboard azimuth thruster was not responding and that he had neither steering nor speed control over the starboard thruster.

3.6.12. The master went back and forth between the two control stations, but did not succeed in regaining control of the starboard azimuth thruster.

3.6.13. Realising that the vessel was fast approaching the Devonport ferry terminal, he decided to abort berthing and used the port thruster to alter course to starboard in an attempt to turn and head back to open water.

3.6.14. However, there was not enough room to execute the turn using the port thruster alone. The master soon realised that a collision with Devonport's Victoria Wharf was imminent and reversed the port thruster to reduce the speed of the vessel.

3.6.15. Shortly afterwards the vessel's starboard bow collided with a concrete pile on Victoria Wharf.

Figure 6
Impact damage to the *Kea*'s starboard bow area

3.6.16. The master was preoccupied and had no time to make an announcement on the public address system warning passengers of an imminent collision.

3.6.17. A number of passengers were thrown forward onto the deck. In some areas, the plastic seats on which they were sitting were not secured and toppled during the collision.

3.6.18. Soon after impact the deckhand carried out an internal assessment of the hull and confirmed that the damaged area was above the waterline.

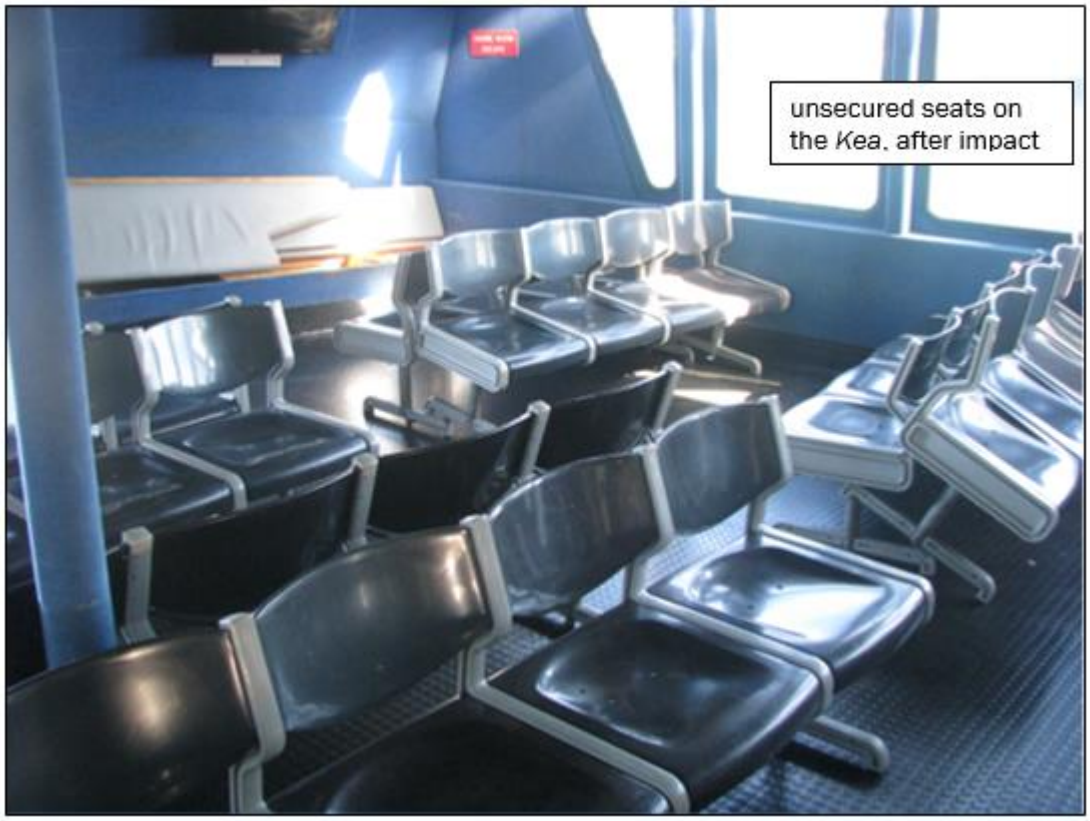


Figure 7
Unsecured seats on the *Kea*

3.6.19. About a minute after impact, the master was able to regain control of both engines and manoeuvred the vessel to the Devonport passenger terminal where emergency services were waiting to provide assistance.

4. Analysis

4.1. General

4.1.1. When the *Kea* collided with Victoria Wharf it was a little over three months since the vessel had resumed service with a new propulsion and steering control system.

4.1.2. During that time the control levers had faulted in the follow-up mode on several occasions, resulting in a number of incidents. When Fullers purchased the new control system, a key requirement was a follow-up capability, in which all levers on all control stations constantly followed the lever in control. When the *Kea* departed Oceania Marine's shipyard to travel to Auckland and resume commercial service, the owner was aware of reliability issues with some of the control levers.

4.1.3. A senior master had received informal training from the manufacturer's engineers at the time of commissioning and had then been entrusted with training other masters who operated the *Kea*. The lack of a structured training programme is discussed in the following analysis.

4.1.4. Also discussed is the level of surveyor and company oversight and Fullers' response to the recurring control system-related incidents.

4.1.5. The Commission has identified the following safety issues, which are discussed in this section:

- the Fullers training and familiarisation system failed to ensure that the master was properly trained in and familiar with the *Kea*'s propulsion control system
- the Fullers system allowed the *Kea* to enter and continue service using the follow-up mode of operation, despite the company knowing that there were faults with that mode that were resulting in incidents
- neither the operator nor the surveyor ensured an appropriate level of surveyor oversight of the project to replace the *Kea*'s propulsion control system
- Fullers had not assessed the risk of operating ferries with unsecured passenger seating.

4.2. The collision

4.2.1. The *Kea* was travelling at full speed on the approach to Devonport Wharf when the master attempted to transfer control of the propulsion units from the Forward1 control station to the Wing1 control station. He succeeded in transferring control of the port propulsion unit, but not the starboard unit. Importantly, he was unaware that he did not have control of the starboard propulsion unit until the *Kea* had entered a confined area with limited room to turn away or stop in time to avoid a collision.

4.2.2. There are three scenarios that might explain why control of the starboard propulsion unit was not achieved:

- the master did not fully depress the give-away button for the starboard control lever
- the control levers for the starboard propulsion unit on the two consoles were not aligned when he attempted to transfer control
- some form of mechanical or electrical fault prevented the transfer.

4.2.3. No mechanical or electrical fault could be found or replicated that would have prevented the transfer of control, so it is therefore unlikely to have been the cause. However, the possibility that some intermittent fault occurred could not be excluded.

4.2.4. If the starboard thruster control levers on the Forward1 control station and the Wing1 control station were not aligned at the time of transfer, the transfer of control would not have been achieved. This was a prerequisite for the successful transfer of control between the two stations. The master was confident that the levers at both consoles were aligned in their normal change over positions, dead ahead and maximum thrust. This is therefore unlikely to have been the reason for the transfer not being achieved.

4.2.5. It is about as likely as not that the master did not push the give-away button with sufficient force to initiate the transfer. The transfer button was beneath a flexible, plastic, water-resistant shield, which had to be depressed with sufficient force to push/click the underlying button. During subsequent trials it was found possible to not activate the underlying button if the push was not hard enough or off-centre.

4.2.6. Each give-away button on each console was equipped with an audible alarm that sounded when the button was pressed to initiate a transfer sequence. Normally, a failure to push a button properly would not activate the transfer alarm. However, it was standard practice to press both give-away buttons simultaneously. If one button was pushed correctly and the other was not, one alarm would sound, but it would not be recognisable that the other did not because the two alarms were indistinguishable from each other.

4.2.7. The audible alarm was supplemented by a flashing visual indicator on the graphic display panel. The audible alarm sounded three times in a period of about 10 seconds, then stopped, irrespective of whether or not control had been accepted at the receiving control station. After a further 20 seconds the alarm sequence was repeated until the control transfer procedure was cancelled or accepted at the receiving control station.

4.2.8. When the master initiated the transfer sequence, he heard the audible alarm but did not confirm that the visual indicators were flashing. When he walked over to the Wing1 control station and pushed the accept-control button, he heard the audible alarm stop but did not check the graphic display panel to confirm that the transfer had taken place. Tests showed that it took about 10 seconds to press the give-away button on the Forward1 control station and accept control at the Wing1 control station, which was the same duration as the audible alarm before it stopped for a further 20 seconds. This is likely to have led the master to believe that the transfer of both thruster units had been successful.

4.2.9. The incident highlights the importance of masters using all available cues to identify positively or confirm the status of the propulsion system. This is discussed further in the following section on training.

4.2.10. Since the accident, the *Kea* has been fitted with eight new control levers and incorporated modifications to reduce the risk of a control system failure. The audible alarms have also been modified to sound continuously until control is assumed at the receiving control station.

Findings

1. It is about as likely as not that the master lost control of the starboard propulsion system because he did not fully press the 'give-away' button on the centre console before taking control at the wing console.
2. It is likely that the master believed he had control of the starboard propulsion by the unfortunate timing of the aural alarms. However, the visual displays on the wing console before him would have shown that he did not have control of the starboard propulsion system.

4.3. Training

Safety issue: the Fullers training and familiarisation system failed to ensure that the master was properly trained in and familiar with the Kea's propulsion control system.

4.3.1. The master had been working for Fullers since 2011 and held an inshore launch Master Certificate of Competency. He had been signed off to drive the *Kea* in 2012 using the previous control system.

4.3.2. In the six months prior to the accident he had carried out nine shifts on the *Kea*. His last shift had been on 21 December 2014, 58 days before the accident. By comparison, regular masters had averaged about 49 shifts in the previous six months.

4.3.3. After the new control system had been fitted the relief master had spent one day together with two other masters undergoing training in how to operate the new control system. He had been shown how to operate the follow-up mode and carried out some practical exercises. There was no sign-off documentation to indicate his level of competency.

4.3.4. On 18 November 2014, he had operated the *Kea* for the first time using the new control system in follow-up mode. However, following a memorandum dated 25 November 2014 (see Appendix 2), he had to familiarise himself with transferring control without the follow-up function, which he felt was quite a different procedure.

4.3.5. He had spent less time operating and familiarising himself with the new control system than other masters, and had a limited understanding of the information available to him on the graphic display panels on the consoles. He was also unfamiliar with the emergency steering and shut-down mechanisms for the propulsion systems in the event of an emergency.

4.3.6. When the follow-up function was disabled the master was required to transfer controls using the bumpless mode, a mode that he was even less familiar with. He relied on the audible alarm to confirm that a transfer had occurred, but was not aware that it would sound three times (about 10 seconds) and stop, irrespective of whether or not the controls were accepted at the receiving control station.

4.3.7. Just prior to the accident, when the skipper realised that he had no control of the starboard thruster, there were two emergency procedures he could have used to avert or reduce the impact of the collision. The first was using the emergency non-follow-up mode, and if that failed he could have used the emergency stop button to shut down the starboard thruster. The master was unfamiliar with both systems and as a result they were not used.

4.3.8. To better understand why a skipper was in charge of the *Kea* with such a limited knowledge of the propulsion control system, it is necessary to review the company's training system.

4.3.9. Until April 2014, Fullers had employed a marine manager who, among other things, was responsible for the training and development of marine personnel and for monitoring and enhancing safety standards. Part of his day-to-day responsibilities was managing the marine sign-off[11] process.

4.3.10. The marine manager position was disestablished as a result of restructuring (see Appendix 3 for the new organisational chart). The marine manager's responsibilities were dispersed among other managers. Fullers was unable to provide documentation that clearly indicated who was in charge of crew training and development under the new structure. As a result, there was no structured training programme to ensure that the *Kea*'s crew were competent and signed off to operate the new control system.

4.3.11. When the *Kea* refit was completed the operations manager, who managed the rostering of crew, had assigned a senior *Kea* master to take the vessel back to Auckland.

4.3.12. The master had familiarised himself with the new system with assistance from a ZF Marine technician and the electrical team leader, who demonstrated and explained how the new control system worked. However, the training was ad hoc and it was unclear to what extent the master fully understood the safety systems. There was no training syllabus or induction plan to confirm the quality of the training he received.

4.3.13. Once the vessel was back in Auckland, the senior master had been tasked with training other *Kea* masters on the functionality of the new control system, even though he was not the designated training master. Other masters received training in the same informal manner without any clear training strategy, performance objectives or testing to ensure that they thoroughly understood the operation of the control system.

[11] Confirming that a crew member has met the training, development and operational requirements to undertake a particular task.

4.3.14. According to the memorandum released by Fullers, only experienced masters instructed in the use of the controls in manual mode should have been in command of the vessel. The skipper in command of the *Kea* when the accident occurred did not have a lot of experience on board the *Kea*. He had not had sufficient instruction in operating the vessel in the non-follow-up (bumpless) mode, and was not sufficiently familiar with the intricacies of the entire propulsion control system.

4.3.15. When this accident occurred, Fullers' system for training and signing off skippers lacked the processes and clarity of responsibilities to give effect to the memorandum that it had released.

Finding

3. The master had not received adequate training on the *Kea*'s new control system. He had a limited understanding of the system's functionality and the various back-up functions he could have used to regain control of the *Kea*.

4.4. Risk

Safety issue: the Fullers system allowed the Kea to enter and continue service using the follow-up mode of operation, despite the company knowing that there were faults with that mode that could (and did) result in incidents.

4.4.1. Right from the time the *Kea* was reintroduced to service, Fullers had been aware that there were reliability issues with the control levers and therefore a risk of the control system malfunctioning in the follow-up mode. No risk assessment was undertaken to establish what the risks were, and what could be put in place to mitigate the risks.

4.4.2. Even when the *Kea* began having incidents caused by the malfunction of the control system in the follow-up mode, and was withdrawn from service, it was twice reintroduced to service before a proper risk assessment had been undertaken.

4.4.3. Only after the third occasion of the *Kea* being withdrawn from service did Fullers undertake a formal risk assessment, which resulted in the only logical action – to prohibit the use of the follow-up mode until its reliability had been proven.

4.4.4. Operating the *Kea* using the non-follow-up (bumpless) mode was an acceptable and safe method of operation, provided the master was familiar with operating the vessel in this mode and had adequate training and guidelines to operate the vessel safely. Many other vessels operate with similar systems. That decision should have been made when the *Kea* first re-entered service after the new control system had been installed and it was known to be faulty.

4.4.5. Fullers was the operator and as such had the responsibility of managing all risks in its operation. This is a fundamental requirement it has under maritime rules for safe ship management systems. It has this responsibility regardless of any regulatory intervention.

Findings

4. The *Kea* should not have re-entered service with the follow-up mode of control active once it had been established that the system was faulty and unreliable.

5. Fullers did not adequately manage the risks associated with the replacement of the *Kea*'s propulsion control system and the vessel's re-entry to service.

4.5. Surveyor Intervention

Safety issue: neither the operator nor the surveyor ensured an appropriate level of surveyor oversight of the project to replace the Kea's propulsion control system.

4.5.1. Maritime Rules Part 19 requires commercial marine operators to have Maritime Transport Operator Certificates for their maritime operations and Certificates of Survey issued by recognised surveyors for all vessels in their operations.

4.5.2. Fullers received its Maritime Transport Operator Certificate from Maritime New Zealand on 16 January 2015. To maintain this certificate, it was required to comply with all relevant Maritime Rules. Maritime Rules Part 19 and Part 44 detail the responsibilities of maritime transport operators and surveyors.

4.5.3. Maritime Rules Part 44 prescribes the requirements for the survey, certification and maintenance of ships operated under Maritime Transport Operator Certificates. It requires a surveyor who undertakes a survey of a major modification to assess the degree and nature of the risks associated with the modification and satisfy themselves that the modified equipment is fit for purpose.

4.5.4. Part 44 defines 'major modification' as:

> an alteration or modification of a ship, including the replacement, removal, or addition of any part of a ship that is likely to
>
> (a) significantly affect the structural integrity, tonnage, freeboard, cargo or passenger capacity, crew or passenger accommodation, conditions of assignment of load line, watertight subdivision, stability, or structural fire protection; or
>
> (b) result in significant changes to the propulsion machinery, auxiliary machinery, or steering or the method of propulsion of the ship:

4.5.5. Further, Maritime Rules Part 19 states that a Certificate of Survey issued for a vessel only remains valid if any major modification to the vessel has been approved by a recognised surveyor.

4.5.6. When Fullers decided to replace the existing control system, its understanding was that the new ZF Marine control system was a 'like for like' with the existing system and did not consider the project a 'major modification'. The project involved the complete dismantling of the existing propulsion control system, including propulsion interfaces, hardware and cabling. The new control system was built by the same manufacturer and provided the same function as the existing system. However, it was a completely new control system with different components and interfaces with the propulsion units.

4.5.7. The former asset manager approached a surveyor with many years' experience in surveying Fullers vessels and informed him of its decision to replace the *Kea*'s control system with a 'like for like' system. The surveyor did not consider himself an expert on control systems. He decided that the new system was not a major modification that would require his involvement throughout the project. He was told that a reputable marine electronics firm was installing the new system and that the equipment manufacturer was going to oversee its commissioning.

4.5.8. It was therefore reasonable for him to not be involved at every step of the installation project. It is a matter of interpretation whether under Maritime Rules Part 44 the project met the criteria of a major modification, or if it was in fact a modification at all. Regardless of whether it was or not, the control system is a critical system, the failure of which could have serious consequences. It was therefore appropriate that a surveyor be at least involved in the commissioning of the system, including the sea trials.

4.5.9. As mentioned in previous sections, Fullers' rigour preceding its acceptance of the *Kea* from the manufacturer could have been better. An independent surveyor's involvement in this process would have introduced another level of scrutiny to the system reliability, particularly if

the surveyor had been privy to the information from the manufacturer's commissioning report that there were reliability issues with the control levers that were installed.

Finding

6. The *Kea*'s propulsion control system was a critical system, the failure of which could have had serious consequences. The replacement of the whole control system should have been afforded a greater level of scrutiny by a surveyor.

4.6. Safety of passengers

Safety issue: Fullers had not assessed the risk of operating ferries with unsecured passenger seating.

4.6.1. The master did not make any announcements on the public address system before the vessel collided with a concrete pile at Victoria Wharf. Most passengers were therefore unaware of the imminent collision and did not know to brace themselves. Many passengers were thrown out of their seats and injured. A number of injuries were caused by unsecured seats landing on top of the passengers.

4.6.2. Maritime Rules Part 40A.18 prescribes the requirements for seating in passenger accommodation spaces. The rule states that:

> A ship that engages in voyages of **30 minutes'** duration or more must be equipped with seating for every passenger that the ship is certified to carry, in accordance with this rule.

4.6.3. The *Kea* took about 15 minutes to complete a single transit between Auckland and Devonport and therefore this part of the rule was not applicable. The rule does not require seats to be secured on board a vessel, and in the *Kea*'s case there was no requirement to have a seat for every passenger.

4.6.4. The base of each seat on the *Kea* was capable of being secured to the deck. Given the operator's responsibility to take all reasonable precautions to protect the safety of passengers and crew, securing the seats would have been a well-considered precaution that would likely have reduced the number and severity of injuries to passengers.

4.6.5. Since the accident, Fullers has carried out a risk assessment of its fleet and mitigated this risk by securing seating on all of its ferries.

Finding

7. Securing the seats to the deck would have been a well-considered precaution that would likely have reduced the number and severity of injuries to passengers.

5. Findings

5.1. It is about as likely as not that the master lost control of the starboard propulsion system because he did not fully press the 'give-away' button on the centre console before taking control at the wing console.

5.2. It is likely that the master believed he had control of the starboard propulsion by the unfortunate timing of the aural alarms. However, the visual displays on the wing console before him would have shown that he did not have control of the starboard propulsion system.

5.3. The master had not received adequate training on the *Kea*'s new control system. He had a limited understanding of the system's functionality and the various back-up functions he could have used to regain control of the *Kea*.

5.4. The *Kea* should not have re-entered service with the follow-up mode of control active once it had been established that the system was faulty and unreliable.

5.5. Fullers did not adequately manage the risks associated with the replacement of the *Kea*'s propulsion control system and the vessel's re-entry to service.

5.6. The *Kea*'s propulsion control system was a critical system, the failure of which could have had serious consequences. The replacement of the whole control system should have been afforded a greater level of scrutiny by a surveyor.

5.7. Securing the seats to the deck would have been a well-considered precaution that would likely have reduced the number and severity of injuries to passengers.

6. Safety actions

General

6.1. The Commission classifies safety actions by two types:

(a) safety actions taken by the regulator or an operator to address safety issues identified by the Commission during an inquiry that would otherwise result in the Commission issuing a recommendation

(b) safety actions taken by the regulator or an operator to address other safety issues that would not normally result in the Commission issuing a recommendation.

Safety actions addressing safety issues identified during an inquiry

6.2. Below is a summary of mitigating steps taken by Fullers following the *Kea* collision incident. They have been classified into three categories: Personnel and Training, Vessel Systems and Safety Management System.

Personnel and Training

Enhanced training regime established for the MV Kea, and across Fullers.

Appointment of a dedicated training Master for Kea to ensure consistency and quality of training. This person was put through a formal training assessment unit standard and assisted the development of the training regime.

All Kea training material was comprehensively reviewed and new requirements were put in place in order to establish complete and comprehensive understanding of the vessel specific systems, including the requirement for the Master to complete a full task book on all vessel systems prior to assuming command and Including the enhanced requirement to demonstrate proficiency in the use of all three vessel emergency back-up systems.

Comprehensive review and enhancement of vessel manuals and instructions with easy to follow decision trees for the activation of emergency overrides, these are stored on-board, and available on the vessel's tablet and intranet.

Electrical Team Leader and vessel system specialist sent to ZF Holland for comprehensive system training for the Kea control system. Appointment of General Manager Assets and Compliance to oversee all asset and compliance functions across Fullers and 360, including maintenance and vessel systems.

Vessel Systems

Installation of GPS/RADAR Plotters at all of Kea's control panels where previously these were located only at the central control positions.

Installation of HD CCTV Cameras for passenger, boarding areas and engine rooms. Any footage can be retained within a 48 hour period.

Seating arrangements have been properly secured on all ferries.

Installation of a separate LED indicator on the control panel alerting the master to the "live" control panel, to ensure transfer is unequivocally established.

Modification of the audible alarms that sound continuously until control assumed at the relevant control position.

Modification of system software to allow the forced override function to be requested from any control panel.

Safety Management System

Implementation of new web based Safety Management Software 'Risk Manager' which allows employees to lodge risks, hazards, near misses, and incidents, that

then generates trackable actions in real time for next steps and providing senior leadership visibility of all risks and incidents.

Kea Control heads swapped out at 6 monthly intervals and sent to ZF Holland for assessment to monitor wear on critical components. Enhancing maintenance over and above manufacturer's requirements.

Masters must complete full task book on all vessel systems prior to assuming command on all vessels. Task books require vessel specific information. Masters must demonstrate proficiency in the use of all vessel emergency back-up systems on all vessels. In the case of MV Kea backup systems include NFU Mode; Control heads bypassed using control arrow buttons, Forced Over-ride; overriding the system from any control position and Emergency Stops; shuts down engine and propulsion machinery.

Standard Operating Procedure Variations require Master sign off as read and understood.

Safety Tool Box talks conducted at regular intervals and recorded.

Safety actions addressing other safety issues

6.3. None.

7. Recommendations

General

7.1. The Commission may issue, or give notice of, recommendations to any person or organisation that it considers the most appropriate to address the identified safety issues, depending on whether these safety issues are applicable to a single operator only or to the wider transport sector. In this case, recommendations have been issued to Maritime New Zealand.

7.2. In the interests of transport safety, it is important that these recommendations are implemented without delay to help prevent similar accidents or incidents occurring in the future.

Recommendation

7.3. Maritime Rules Part 44 prescribes the requirements for the survey, certification and maintenance of ships operated under Maritime Transport Operator Certificates. The rule requires that a surveyor assess the scope of any proposed work on board a vessel and, if they consider it to be a major modification, undertake a survey of the work, assess the degree and nature of the risks associated with the modification and satisfy themselves that the modified equipment is fit for purpose.

It is a matter of interpretation whether under Maritime Rules Part 44 the project to replace the *Kea*'s control system met the criteria of a major modification, or if it was in fact a modification at all. Regardless of whether it was or not, the control system is a critical system, the failure of which could have serious consequences. It was therefore appropriate for a surveyor to have at least been involved in the commissioning of the system, including the sea trials.

On 23 August 2017, the Commission recommended that Maritime New Zealand issue guidance and advice to operators and surveyors about the need to take a risk-based approach when determining the level of surveyor oversight required for changes to critical systems, regardless of whether or not the changes are considered major modifications. (026/17)

7.3.1. On 13 September 2017 Maritime New Zealand replied:

> I write in response to your letter of 23 August 2017 in which you set out the final recommendation on the above inquiry and ask that I inform you of Maritime New Zealand's intentions in respect to the same.
>
> The Commission has recommended that Maritime New Zealand issue guidance and advice to operators and surveyors regarding the need to take a risk-based approach when determining the level of surveyor oversight required for changes to critical systems, regardless of whether those changes are considered major modifications.
>
> I agree that maritime operators taking a risk-based approach to surveyor oversight of changes to critical systems is a sound approach. I also agree that a similar approach is appropriate for the work of surveyors.
>
> I am advised that, because of the way that Maritime Rules Parts 44 and 19 are constructed, the issuance of such guidance may not achieve the intended effect. That is because they do not define 'critical systems' and they only require surveyor oversight and approval in the event of a major repair or a major modification.
>
> It is my view that the more enduring way of achieving the objective identified by the Commission is to review the legal framework to support a risk-based approach to surveyor oversight. This would require amendments to Rule Parts 19 and 44; in particular, the addition of a definition of 'critical systems' and clarity as to the point at which surveyor oversight is required in the process of critical system changes.
>
> Maritime New Zealand currently has a programme of work on its current regulatory programme which is well suited to consider this matter at some depth and may result in a proposal to change the rules, subject to Ministerial agreement. As the Commission may appreciate, if changes to the rules are required, this process could take a couple of years to complete.

8. Key lessons

8.1. Masters and other bridge crew must use all available means for monitoring the status of their manoeuvring and control systems, all the time, to maintain good situational awareness.

8.2. Masters must be properly trained in and fully familiar with all aspects of their vessels' control systems and equipment before being allowed to take command of them.

8.3. The regulatory requirements contained in Acts, Maritime Rules and other statutory instruments are minimum requirements with which maritime operators must comply. They do not relieve operators of their responsibility to assess all risks in their operations, and reduce those risks to as low as reasonably practicable.

Appendix 1: Memorandum – 21 November 2014

Memorandum

Fullers
We'll take you there

To:	**Kea Masters, Duty Managers**
From:	**Health and Safety**
Date:	**21 November 2014**
Subject:	**Kea Temporary Operating Procedures**

Most of you will be aware that the new control heads on Kea have been faulting, resulting in a number of potentially serious control failure incidents.

After discussion with the Maintenance team and two Kea masters the decision was made to disable the follow function on the control system.

This was determined to be the safest option as future failures could not be predicted.

This will remain in place until the control system suppliers ZF have come up with a permanent solution.

In the interim could we please ask that the following be observed:

- All vessel control to be done from the wing position
- Follow function not to be reinstated under any circumstances unless agreed by asset manager.
- Additional watch keeping crew to be available to the master should they be requested
- Any 'giveaway' or 'accept control' to be done with plenty of sea room available unless tied alongside at Devonport or Downtown Ferry Basin.
- Any future control issues to be recorded in vessel log
- Only experienced masters who have been instructed in the use of the controls in the manual position to be in command of the vessel.

Many thanks

[redacted]
Health and Safety Manager

Appendix 2: Memorandum – 25 November 2014

Memorandum — Fullers *We'll take you there*

To:	**Kea Masters, Duty Managers**
From:	**Health and Safety**
Date:	**25 November 2014**
Subject:	**Kea Temporary Operating Procedures (amended)**

Most of you will be aware that the new control heads on Kea have been faulting, resulting in a number of potentially serious control failure incidents.

After discussion with the Maintenance team and two Kea masters the decision was made to disable the follow function on the control system.

This was determined to be the safest option as future failures could not be predicted.

This will remain in place until the control system suppliers ZF have come up with a permanent solution.

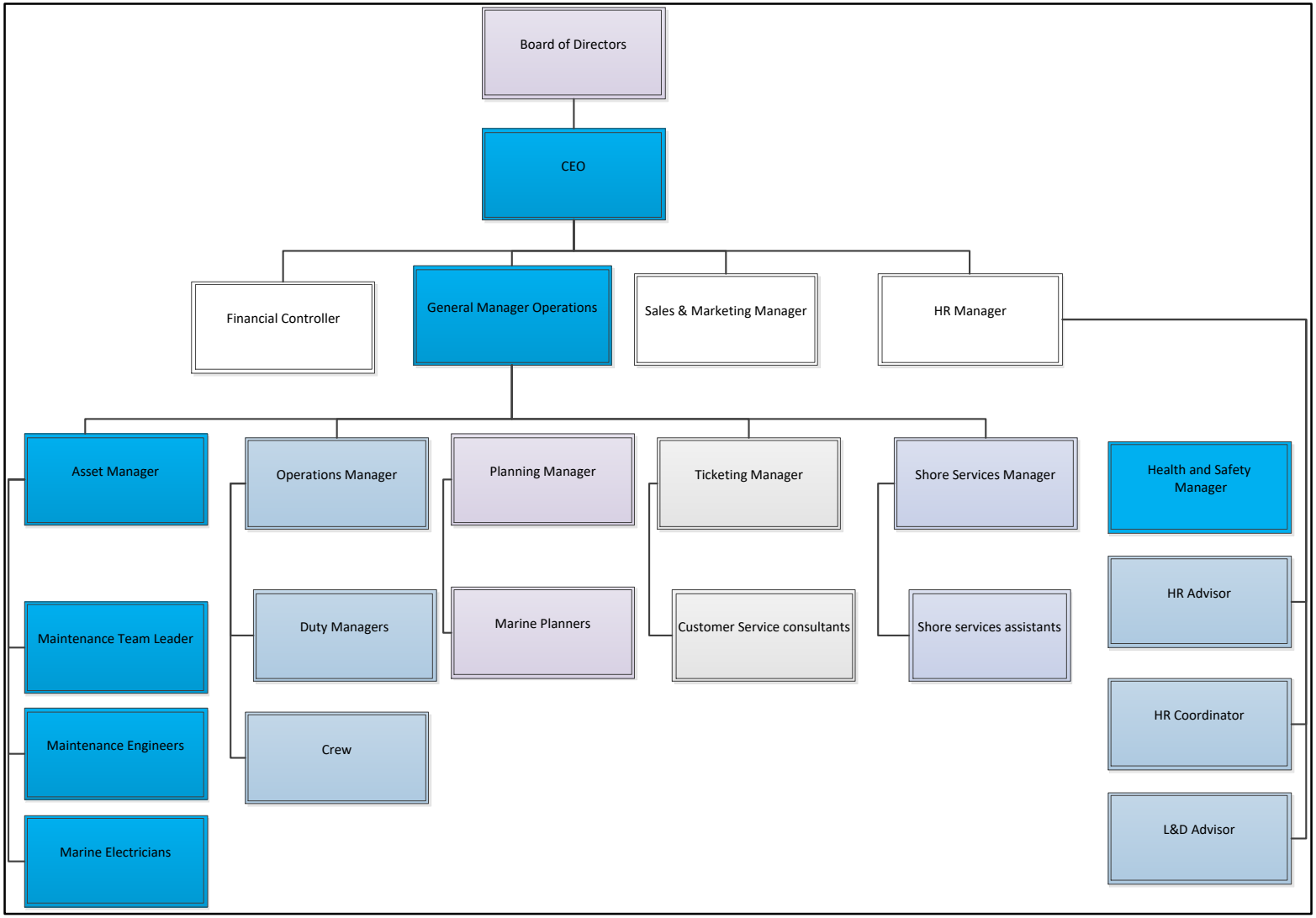
In the interim could we please ask that the following be observed:

- Central controls may be used between Auckland and Devonport, however wing control position must be resumed about abeam of the naval dry dock on the Akl-Devo and between Captain Cook & Queens Wharf on the Devo-Akl.
- Follow function not to be reinstated under any circumstances unless agreed by asset manager.
- Additional watch keeping crew to be available to the master should they be requested
- Any 'giveaway' or 'accept control' to be done with plenty of sea room available unless tied alongside at Devonport or Downtown Ferry Basin.
- Any future control issues to be recorded in vessel log
- Only experienced masters who have been instructed in the use of the controls in the manual position to be in command of the vessel.

Many thanks

[redacted]
Health and Safety Manager

Appendix 3: Fullers' company structure



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MO-2010-206	Coastal container ship *Spirit of Resolution*, grounding on Manukau Bar, Auckland, 18 September 2010
MO-2014-202	Lifting sling failure on freefall lifeboat, general cargo ship *Da Dan Xia*, Wellington, 14 April 2014
11-204	Container ship MV *Rena* grounding, on Astrolabe Reef, 5 October 2011
13-201	Accommodation fire on board the log-carrier, *Taokas Wisdom*, Nelson, 11 July 2013
13-202	Bulk carrier, *IDAS Bulker*, pilotage incident Napier, Hawke's Bay, 8 August 2013
12-202	Fishing vessel *Torea*, collision with uncharted rock, Foveaux Strait, 24 August 2012
09-210	Bulk carrier, *Taharoa Express*, cargo shift, Port Taharoa, 16 December 2009
10-204	Inquiry 10-204: Bulk carrier *Hanjin Bombay*, grounding, Mount Maunganui, 21 June 2010
10-202	*M.V. Anatoki*, grounding, off Rangihaeata Head, Golden Bay, South Island, 6 May 2010
11-204	Interim Report Marine inquiry 11-204 Containership MV *Rena* grounding on Astrolabe Reef 5 October 2011
09-202	Marine Inquiry 09-202: Passenger vessel *Oceanic Discoverer* Fatal injury, Port of Napier 19 February 2009

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